



# Nexus

An Agent-Based Simulation Platform  
for Planning & Management of Multi-  
modal Transit Systems

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# Outline

- Introduction
- Overview of Nexus
- Use Cases
- Future Plan





# Introduction



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# What is Nexus?

- Nexus is a
  - Software platform combining big data, simulation and other models/analytics to support transit planning and management
  - Built on a services architecture to allow it to run across a network of computers



# Motivation for *Nexus*

- Devising response measures require high-fidelity modelling systems with capability to:
  - Properly represent dynamic performance of individual transit lines, stations and system as a whole (including interface spots)
  - Realistically model passenger travel behaviour under normal and irregular conditions
  - Realistically represent scenarios of disruptions and emergencies, and response strategies



# What can Nexus do?

- Nexus aims at allowing the user to
  - Quickly build or update a transit network model based on GTFS and other big transit data (important for short range planning, scheduling and management)
  - Simulate operations and demand
    - of all transit modes: rail, bus, streetcar and pedestrian
    - at various spatial levels: rail platform, transit hub, route, corridor, network
    - at different resolution levels: microscopic, mesoscopic, hybrid
  - Represent system and user behaviours under normal conditions or scenarios of service disruption and emergencies



# Potential Areas of Application

- Capacity/Performance Analysis
  - Capacity analysis of subway lines under ATC and other operational improvements
- Capacity and Expansion Studies
  - Impact is traditionally tested in isolation – Nexus offers the ability to test the impact in context of surrounding network



# Potential Areas of Application

- Integrated Route Planning & Scheduling
  - Transfer optimization and accelerated operations
- Network Resilience & Response
  - Current analysis is performed using simplified network models, and can only handle complete removals of network segments
  - Nexus will allow for a broader range of examination, including testing of transient disruptions and accounting for passenger behaviour







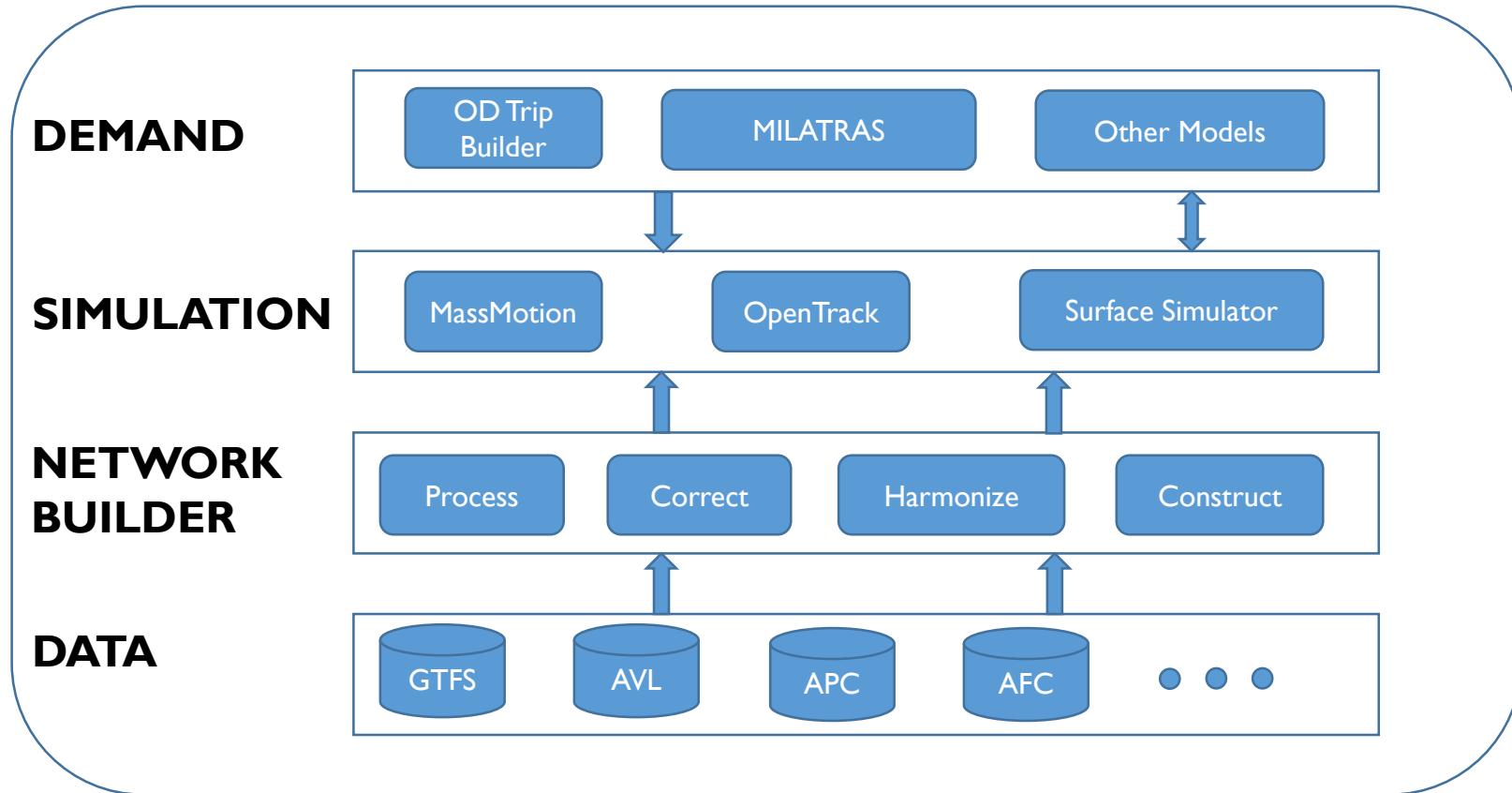
# Nexus Architecture



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# Nexus Framework



# Description of Nexus

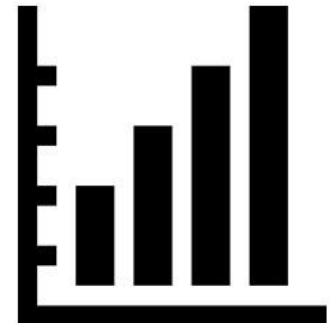
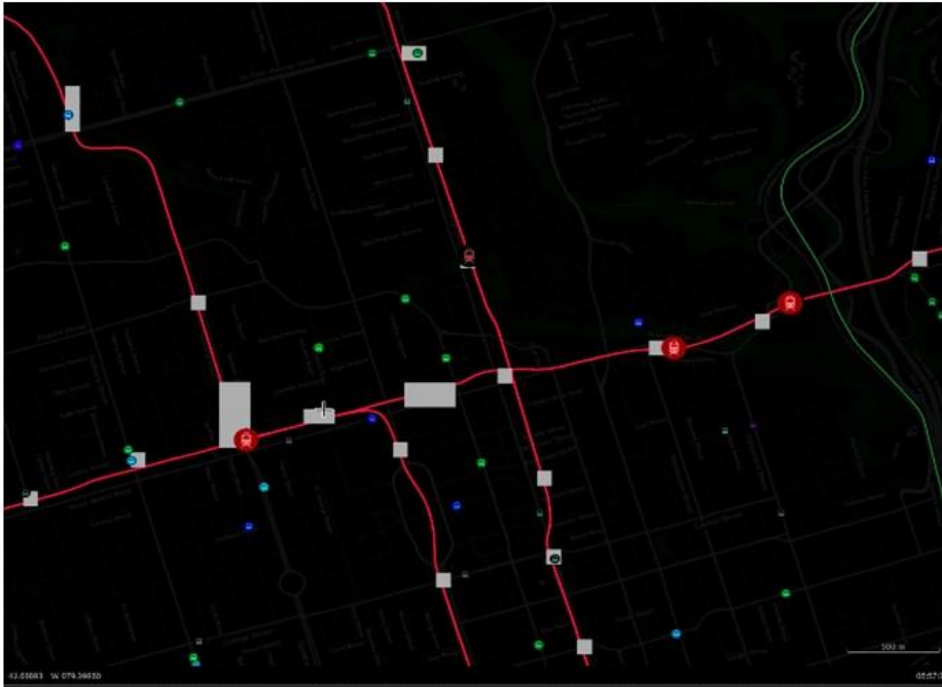


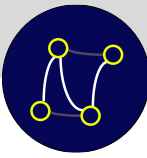
# Description of Nexus



# Nexus Main Features

Live network-view dashboard visualizing key network service performance.





# MILATRAS



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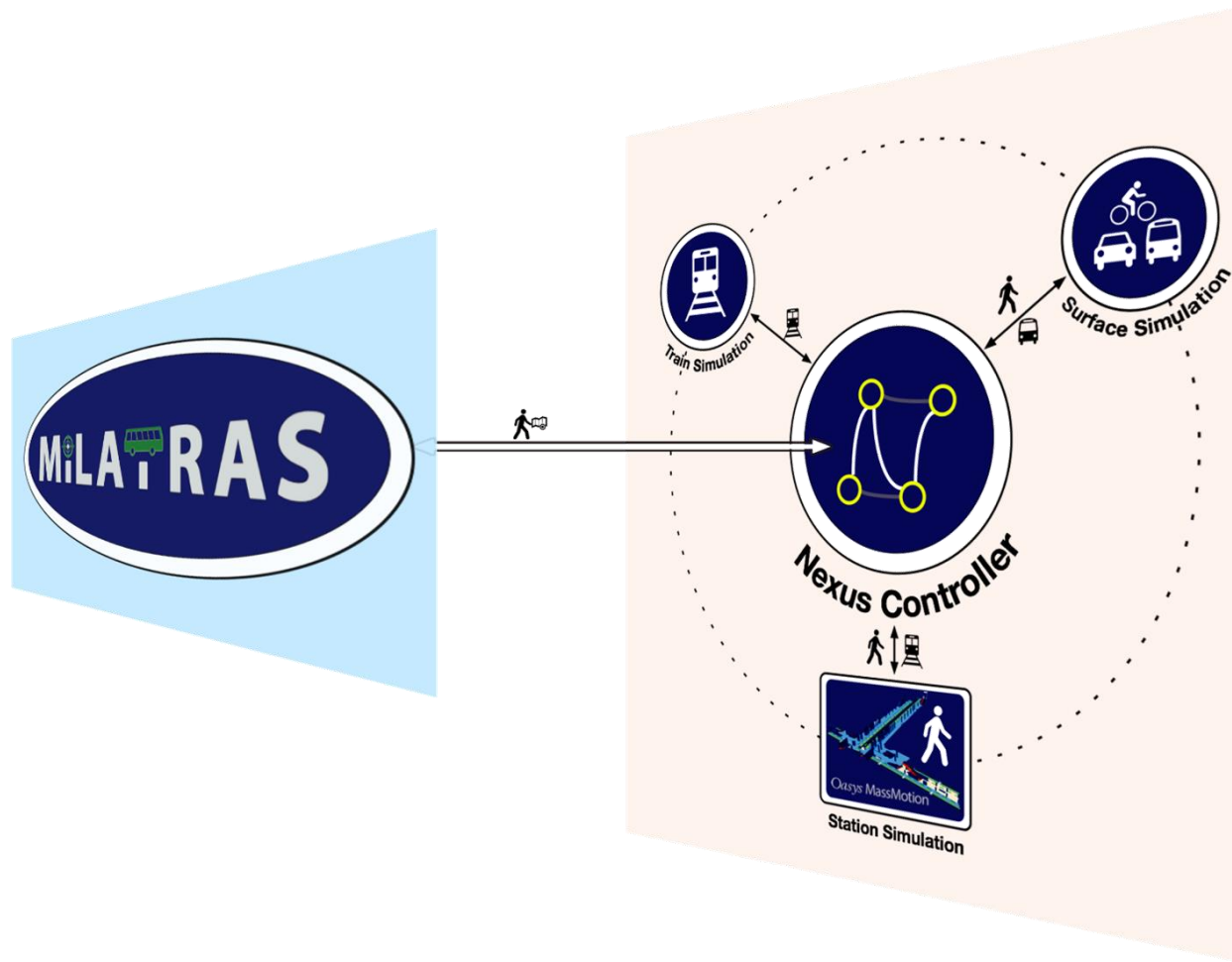


# MILATRAS

- Multi-agent learning based transit assignment
- Models departure time, stop and path choices simultaneously using the Markovian Decision Process and Reinforcement Learning-based techniques
- Cognitive model to represent the learning process of users as they choose stop, path, departure time
- Agents learn from prior experience, update trip choices with each iteration
- Allows for re-routing midway based on new information



# The *Nexus* Platform







# Use Cases



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# TTC Case Study – *Nexus* Prototype

The screenshot displays the Nexus Prototype simulator interface. On the left, a sidebar contains a 'start simulator analyzer' menu, a 'SIMULATOR' tab, and a 'Load Network' button. Below this, a log window shows the following status: 'Software Loaded', 'Network Load Successful', 'Scenario Loaded successfully', 'Bus and Subway Routes Loaded', 'Stations Loaded', 'Stops Loaded', and 'Processing Time: 00:01:25.2592656'. A progress bar is partially filled, and the text 'Running Simulation' is visible. Below the progress bar are 'Run Simulation' and 'Pause' buttons, and a checked checkbox for 'Enable Vehicle Visualization'. The main area is a dark-themed map of a city with a grid of roads. Several transit routes are overlaid: a red route with dashed lines and a green route with solid lines. Small white squares represent stations. On the right, a 'Map Layers' panel lists 'Stations', 'Bus Stops', 'Bus Routes', 'Train Routes', 'Trains', and 'Buses', all of which are checked. Below the layers is a 'Map Opacity' slider. At the bottom of the map, the coordinates 'N 43.67616 W 079.25287' and a '5 km' scale bar are shown. The time '05:49:30' is displayed in the bottom right corner.



# Previous Studies

## Capacity analysis and flow management

Capacity analysis of the USRC

Hub and network flow management

Crowding relief benefits of the DRL

Rail disruption management

Crowding analysis of the B-Y Station

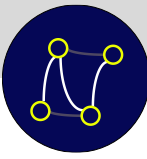
## Other

Specialized route operations

Transfer optimization

Integration with activity based demand model





# The Future



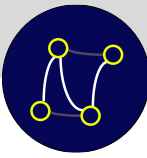
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# Future of *Nexus*

- Web accessible cloud-based implementation on modern cloud services (AWS, Azure)
- Incorporation of an updated version of MILATRAS
- Integration of mesoscopic station and rail simulators being developed by TAL





# Questions?



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